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STABILIZING DEVICE AND METHOD

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KEY:-

R, R', R'' adjustable resistances in the shunt fields of engine generator, generators 3 and motors 4.

Pendulum controlling resistances R, R', R'' (See Fig. 2)

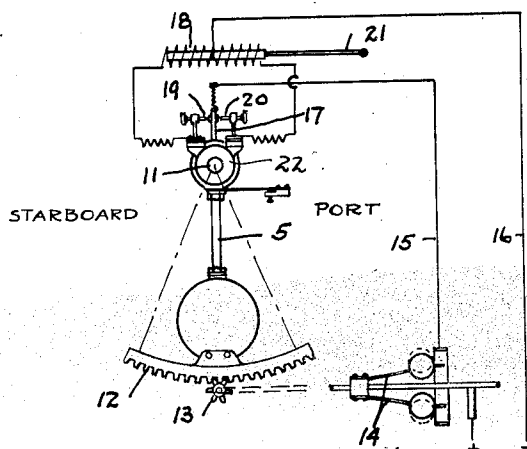
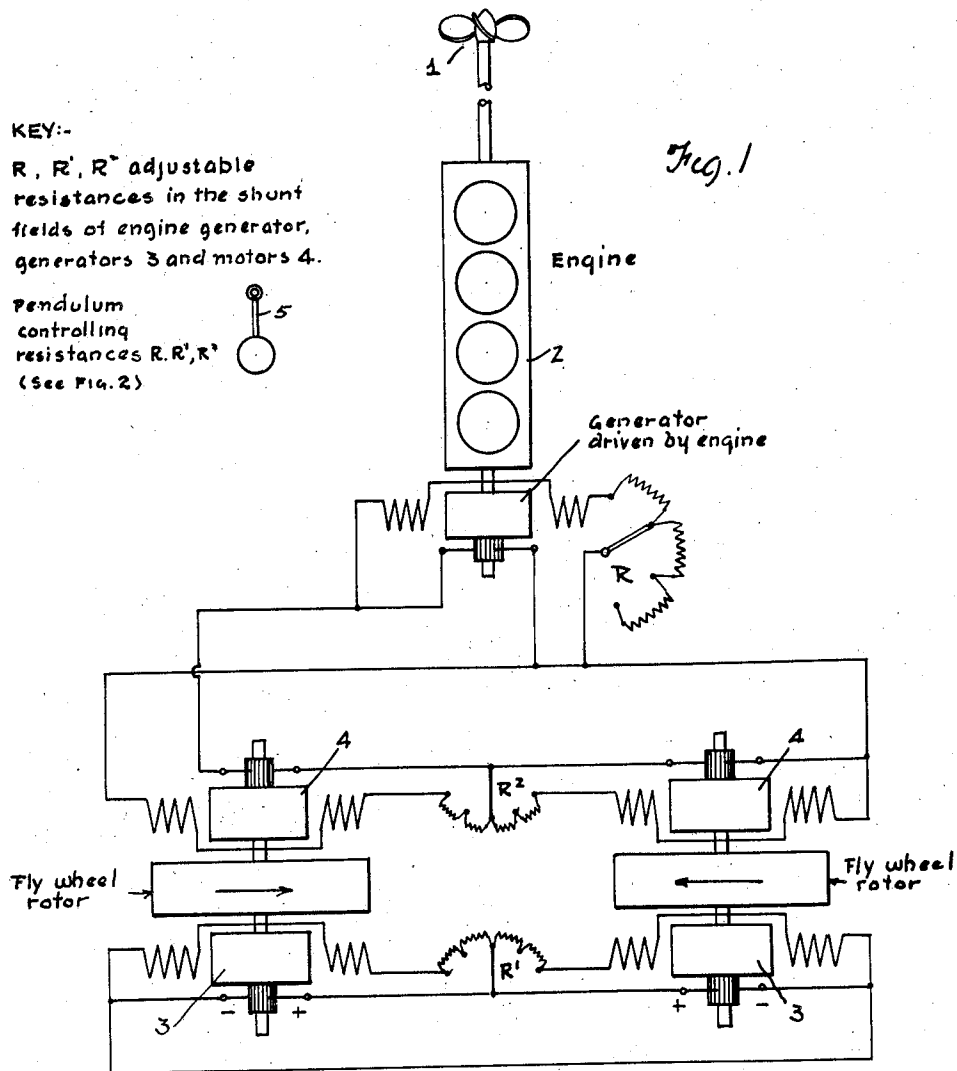


Fig. 2

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STABILIZING DEVICE AND METHOD

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The present improvements have more particular regard to a method and apparatus for reducing the roll of a ship and said improvements are specially applicable, although not limited, to use with a propeller driven ship. The object of the invention is to provide an apparatus that will accomplish the stated result without requiring the expenditure of excessive energy and that may be made to operate automatically, i. e., be brought into action by initial rolling movement of the vessel itself. It will of course be understood that a stabilizing method and apparatus of the character in hand may be employed upon aircraft, and particularly upon buoyant craft, just as advantageously as upon watercraft.

To the accomplishment of the foregoing and related ends, the invention, then, consists of the steps and means hereinafter fully described and particularly pointed out in the claims; the annexed drawings and the following description setting forth in detail certain means and one mode of carrying out the invention, such disclosed means and mode illustrating, however, but one of various ways in which the principle of the invention may be used.

In said annexed drawings:—

Fig. 1 is a more or less diagrammatic representation of an apparatus or mechanism adapted to carry out the present improved method of stabilizing ships or like floating vessels; and Fig. 2 is a similar diagrammatic representation of one form of automatic control device suitable for use in connection with such apparatus.

As is well known, in rough water a ship rolls to port, then to starboard, back to port and so on indefinitely, with a pendulum-like motion. The forces tending to produce this rolling movement may not be very great relative to the weight of the ship, but the application is rhythmic and the pendulum-like swing or roll of the boat is built up gradually to large proportions by the persistent or suc-

cessive application of these relatively small forces. The present invention is designed to utilize forces developed by the ship's engine or motor to resist or neutralize the forces that thus tend to produce the roll of a ship. Briefly stated, I may utilize either changes in propeller torque (where the ship or vessel is one driven by a propeller) or changes in the stored energy (momentum) of a rotor suitably mounted on the ship or vessel, or I may combine the effect of changes in both such propeller torque and rotor momentum.

Referring first to the use of the screw propeller in achieving the object of the invention, it will be noted that incidentally to producing, by means of a screw propeller, the axial thrust which propels the boat through the water or other medium in which it is floating, a turning moment. To increase the rate of revolution, the engine which is fixedly mounted in the ship transmits to the propeller (or propellers where more than one is employed) its turning moment. To increase the rate of revolution of the propeller, increased turning moment or torque is required and this turning moment may therefore be varied by varying the rate of revolution of the propeller. The effect of this turning moment is to cause the ship to roll slightly in a direction opposite to that in which the propeller is turning where a single propeller is used, while if two similar propellers are used and are driven in opposite directions at equal speeds and are respectively made right and left hand, then the moments of torque developed by such propellers will be neutralized one by the other so long as such moments are equal. If, however, the relative speeds of the two propellers be varied, the difference between the altered moments of the port and starboard propellers may be made to act at will toward port or starboard and tend to list the ship accordingly.

Based on the foregoing, I have discovered that by varying the moment of torque deliv-

ered by the ship to the water through the propeller or propellers in such a way as to augment that torque when it is resisting the forces tending to roll the ship and for decreasing that torque when it is assisting the forces tending to roll the ship, the rolling may be measurably reduced. With a plurality of propellers having opposing torques, the stated result is accomplished by increasing the speed and the consequent torque on one propeller and at the same time decreasing the speed and consequent torque of the propeller rotating in the opposite direction as required to resist the moment of the force tending to roll the ship.

In addition to the moment of torque which is passed from the ship to the water through such a screw propeller, the stored energy of rotating parts, such as the propeller blades and connected motor is itself a factor as may be best illustrated by assuming an independent rotating member to be mounted in the ship with its axis of rotation parallel to that of the ship. In such case the momentum of the rotating member is something external to the ship and if its rate of rotation be changed, a commensurate force must be transmitted to it through its mounting on the ship resulting in a like reaction upon its mounting but in an opposite direction producing a moment of torque tending to roll the assembly of rotor, mounting and ship about the rotor axis in a direction opposite to the direction of change in rate of rotation.

In actual practice a combination of the two methods of control will be desirably employed and such a combination is illustrated in the drawings.

Referring to Fig. 1, a single screw propeller 1 is shown as driven by a suitable engine or motor 2. Preferably aligned with the ship's axis of oscillation are two electric generators 3 that are driven to rotate in opposite directions by corresponding electric motors 4, the latter being so connected electrically that generated voltages are opposite and that when rotating at the same speed, no current will pass between them or, in other words, no power will be delivered by one to the other. Under such conditions, the electric motor drives will merely overcome windage and friction. For convenience in drawing layout, the rotors are shown as spaced laterally, but it will be understood that in practice they will be located to secure most direct effect. The electric current connections between the machines are so arranged that the voltage control will be actuated by a suitable stabilizing means, for instance a control gyroscope or pendulum, etc., in such a way that listing of the ship will lower the voltage on one of the machines or both lower the voltages on the one and raise it on the other, thus causing a power current to flow from one machine to the other in such a way

that one will act as a generator and the other as a motor driven by its companion. The generating force will be the low torque delivered by the driving motor plus the heavy torque delivered by the heavy generator rotor due to sudden retardation under the load. The companion rotor will be accelerated due to the power input received from the generator and the turning moment delivered to the ship through the stationary parts of the motor generators by retardation and acceleration of the rotors will resist the turning moment of the outside forces tending to list the ship in one direction.

By reversing the above sequence of events, that is, by using the first rotor as motor and the second as generator, the effect of the turning moment delivered by the acceleration and retardation respectively of the two rotors will be opposite to that just described and will resist turning moment of outside forces tending to list the ship in that direction. In other words, the two motor generators will alternately deliver and receive power from each other in sequence determined by the pendulum, gyroscopic or other device which may be used to actuate the voltage control mechanism. The total energy which has been stored up in the rotors by the driving motors will remain a substantially constant amount equally divided between them (if alike) when running at the same speed, but unequally divided when at different speeds. The voltage control actuated by the stabilizing device will then cause shifting of energy from rotor to rotor back and forth in such a way that the torque developed by such shifting will resist the tendency of the boat to list by reason of outside forces.

The manner in which the torque of the propeller may be combined with the momentum of the rotor to act in a stabilizing manner is likewise shown in the drawing, which illustrates the use of a single propeller, it being sufficient to explain that the same stable device that controls the electric current connections between motors 4 is also connected either directly or preferably through suitable relay mechanism with the speed control mechanism of the engine 2 or equivalent turbine or motor that drives the propeller. The connection between such device and speed control mechanism of the power unit is so arranged that when the pendulum swings to starboard, it will vary the propeller speed to increase the moment of torque to port or reduce it to port, depending upon the direction of rotation of the propeller, and vice versa, when the pendulum swings to port, it will act to vary the speed so as to increase the moment of torque to starboard or decrease its moment to port.

For convenience in illustration a pendulum control is shown, but it is to be understood that any suitable control may be used, 130

a gyroscope being especially desirable. As illustrated, a pendulum 5 is mounted to swing on a pivot 11, such pendulum being hung so as to swing transversely of the ship and its pivot being preferably located at the center of oscillation. Dampening means (not shown); in the form of dash pots, for example, will be provided to prevent undue oscillation of the pendulum. Attached to the latter is a segmental gear 12 that engages with a pinion 13 with which is connected a centrifugal contactor 14. When in operative position the latter closes the circuit through leads 15 and 16, the first of which is connected with a contact 17 mounted on the upper end of the pendulum adjacent the pivot 11, while the other is connected at an intermediate point with a solenoid 18. The respective ends of said solenoid are suitably connected with adjustable contacts 19 and 20 located on opposite sides of the contacts 17 and carried upon a loose collar 22 journaled freely on the pivot 11. Armature 21 of the solenoid is connected by means of a rod to the previously described device whereby the changes in speed of the engines, turbines or other rotating members in the ship, which changes are to be utilized for stabilization, are accomplished.

The operation of the device just described may now be briefly set forth. Assuming the ship to be on even keel, the pendulum will be at rest with all contacts open and the rotating members running at equal speed. If now the ship begins to list to port, the pendulum starts to swing to port, making a starboard contact, and the centrifugal contactor revolves and closes the circuit to energize the starboard end of the solenoid. The armature of the latter consequently is shifted to starboard and operates speed control mechanism to accelerate the starboard rotor and/or screw and to retard the port rotor and/or screw. When the increase in list to port stops, the pendulum swing ceases, the centrifugal contactor ceases to revolve and opens the circuit through the solenoid, the armature of which returns to neutral. As a result the speed control mechanism is caused to retard the starboard rotor and screw and accelerate the port rotor and screw towards equal speeds and initial status. When the ship begins to right itself, the solenoid will be reversely actuated to develop accelerating and retarding forces opposite to those just described.

When neither end of the solenoid is energized, the armature 21 is automatically returned to neutral position in which position it has moved the speed changing device to restore the rates of rotation of the rotor, rotors or propeller to normal, and when either the port or starboard end of the solenoid is energized, the armature will move to port or starboard, and in such positions will operate to change the rates of rotation of the

propeller, or the rotor or rotors to develop a reaction opposed to the direction in which the ship is rolling.

It will thus be seen that I provide in general a stabilization by positive and negative acceleration of rotating parts as determined by requirements; and where commensurate alternate acceleration and retardation is applied to paired rotors electrically coupled and turning in opposite directions, the simultaneous reaction on the ship's hull may be doubled in either direction and may persist in accordance with any craft's natural half period. Moreover, the system is applicable in various arrangements, compensatively changing the speed of the turbines or other prime movers, changing the propeller torque, or changing the inertia of a rotor, or combinationally, as desired.

Other modes of applying the principle of my invention may be employed instead of the one explained, change being made as regards the means and the steps herein disclosed, provided those stated by any of the following claims or their equivalent be employed.

I therefore particularly point out and distinctly claim as my invention:—

1. The method of stabilizing propeller driven craft, which comprises varying the speed of a rotating member mounted thereon so as to oppose the reaction due to the acceleration or deceleration of said member to the roll of the craft, and reenforcing the so-obtained opposing moment by varying the speed of the propeller in such manner as to increase said moment when it will resist the forces tending to roll the ship and to decrease said moment when it will resist such forces.

2. A method of reducing the roll of a ship, which comprises varying the speed of the propeller of the ship as the latter rolls so as to vary the torque reaction of such propeller, and simultaneously varying the speed of a rotating member properly mounted in the ship so as to oppose the reaction due to the acceleration or deceleration of said member to the rolling action of the ship.

3. A method of reducing the roll of a ship, which comprises automatically varying the speed of the propeller of the ship as the latter rolls so as to oppose the change in the torque reaction of such propeller to the rolling action of the ship, and simultaneously automatically varying the speed of a rotating member properly mounted in the ship so as to oppose the reaction due to the acceleration or deceleration of said member to the rolling action of the ship.

4. In a ship stabilizer, the combination with two rotating members mounted in the ship, means interconnecting said members whereby deceleration of either one will accelerate the other, the operation of said means, being controlled by the rolling of the ship,

and means for simultaneously varying the propeller speed.

5 5. Means for stabilizing propeller driven craft, two rotating members mounted on the craft, means interconnecting said members
10 whereby deceleration of either one will accelerate the other, and means including in combination with the propeller, means adapted automatically to vary the speed of said propeller as the ship rolls and vary the speed of the rotating members correspondingly.

Signed by me, this 20th day of October, 1927.

HERBERT H. DOW.